GAS JOURNAL, SEPT. 27, 1944

VOL. 244 96th YEAR No. 4245

EDITORIAL NOTES

TWENTY-FIVE YEARS' SERVICE

OUR news columns to-day carry the announcement of the retirement of Sir David Milne-Watson from the Chairmanship of the National Joint Industrial Council—an office he has held to the Gas Industry's great advantage since the Council was formed twenty-five years ago. We know that he valued the honour all the more because the Council has equal representation from employer and employee; we know, too, that his influence throughout a quarter of a century in creating mutual confidence and trust at a common conference table has been marked by conspicuous success. Of his time and energy in the furtherance of practical understanding between employer and employee in our Industry he has given unstintingly and in abundance over this long period; and his unanimous re-election year by year by both employer side and worker side has, in fact, been recognition of the undoubted flair he has displayed in handling to general satisfaction the always delicate and not infrequently difficult problems with which the Council has been confronted.

The strength of an organization such as the Joint Industrial Council is not built up in a day; it can only be created by hard work, and at the 25th Annual Meeting held on Sept. 15 Sir David referred to the faithful support he had enjoyed throughout. And at a time when so much discussion is being centred on new organizations and associations—of new brooms to sweep the dust away (or is it into people's eyes?) in preparation for something or other vastly superior to anything we have known—it might perhaps be salutary to reflect for a moment on the birth and growth of this Joint Council. It was in 1919 that the Gas Industry, *qua* Industry, took the first positive step to promote monetary agreement between payer and payee, to suggest that a common cause exists between the two, to dispel the conviction that in every case the payer is actuated by motives of grinding the payee and of extracting every ounce from him for the least possible recompense. That year had already seen the formation of the N.G.C., with the provision made for setting up a separate committee of employers to consider matters of hard cash—a committee which in the outcome became the Federation of Gas Employers. Previously, too, there had been publication of the proposals of the Whitley Council, and it was on the basis of these proposals—approved by the Government—that the Joint Council of our Industry came into being, a body consisting of equal numbers of representatives of associations of employers and the Trade Unions. The general function of the Council, of the setting-up of which the Ministry of Labour thoroughly approved, was clearly enough defined—to secure the largest possible measure of joint action between the employers and the workpeople for the development of the Industry as a part of national life and for the improvement of the conditions of all engaged in the Industry. No new broom could, we suggest, at any rate have a better label. More specifically its objects were regularly to review wages, hours of work, points such as overtime, holidays, Sunday pay, and the like, and working conditions as a whole. It is interesting to note that one of the aims was the collection of statistics relating to the Industry—obviously a pious intention of 1920.

For the fruition of this co-operative endeavour, Sir David was elected Chairman of the responsible body consisting of twenty-two employer representatives and twenty-two worker representatives. Mr. W. J. Smith was appointed employer secretary, and Mr. Arthur Hayday was his opposite number in the field. There were many stalwarts in the amicable teams drawn up for the friendly match which has since been in progress, and many of the players—we think, for example, of Mr. Will Thorne, then Lieut.-Col. Thorne, on the one side, and Mr. J. H. Canning on the other—have certainly proved their stamina. We could continue mentioning names of both past and present players, but that is hardly the purport of this short note. We might add, though, that one of the original linesmen was Mr. C. H. Creasey bringing to bear the flag of Education on the friendly contest ahead. Membership of the Council was open to all members of the National Gas Council, from which body, unfortunately, there were one or two notable absentees. However, the Joint Industrial Council became substantially an Industry "voice," supplanting while reinforcing the individual note. Zoning and grading schemes were rapidly established—grading covering areas broadly defined as industrial, commercial or semi-industrial, residential, and agricultural towns and rural villages. There are now eleven regional councils dealing with their own particular problems without, however, impinging on national matters such as wages settlements which affect the Industry as a whole. Essentially, then, the main Joint Council, because of its intimate contact with the regions, is able to obtain the views of the districts, preserve intimacy with local opinion, and frame policy accordingly. And the outcome of all this? Perhaps the true answer lies in the speedy settlement of disputes between different sections in the Industry, and the spirit of understanding which has undoubtedly been created to the advantage of everybody concerned. The newest of brooms with the brightest of bristles will not find much rancour and bitterness between employer and employee in the Gas Industry to sweep away.

It must be pleasurable for Sir David Milne-Watson, if ever, indeed, he has time for reflection, to look back on the twenty-five-year history of the Joint Industrial Council for the Gas Industry, and to know how very greatly his untiring services have been appreciated, how important has been his part in the creation of machinery which needs but little oil to smooth away frictional resistance. While remaining on the Council, he hands over the Chairmanship to Mr. Charles Dukes, C.B.E., who was appointed Vice-Chairman in May of 1934, taking the place of that robust player we have mentioned, Mr. Will Thorne, who remains a Council member.

INDUSTRIAL GAS

WE think there is no doubt that—as Mr. H. S. Milne contended in his North British Paper, which we have published in full in the "JOURNAL"—experience gained during the war has shown how production can be improved by the use of modern methods, and how in this regard gas fits into the picture. We have had the need for maximum production with the minimum use of fuel, and after the war greater regard will be paid to the total cost of fuel per unit of output rather than to the cost per unit of potential heat in the fuel. Consideration will be given not only to the amount of this heat which can be utilized, but to the time factor in production and the saving in labour and material which accompany the use of a particular fuel. In which respect gas does—or should—stand high. Mr. Milne entitled his Paper "Converting the Unbeliever," explaining how, several years ago, he started to interest industrialists in his area of supply in the use of gas instead of oil and other fuels. We imagine that the number of unbelievers now in his area is very small indeed.

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industrial load in a city remote from centres of industrial activity—a story indicative of the rewards which meet faith and determination, and, we may add, cheap gas of proper quality. The latter point is not an unimportant one. The tale is one of individual enterprise, and it was only at the very end of his Paper that Mr. Milne referred to the Industrial Gas Centres, which, at any rate as far as England is concerned, have done invaluable work and have still greater potentialities. They have, in fact, minimized the factor of "remoteness" of gas undertakings, for every undertaking at very little expense gets from the Industrial Centres advice, assistance, and the cumulative benefits of intimate and expert experience. At the same time we are in entire agreement with the Author—we have emphasized the point many times—that every undertaking should do all possible in its area of supply to develop the use of gas industrially by its own individual efforts, and Aberdeen provides example. To derive full benefit from the more enlightened attitude to production now in evidence, personal contact with local industry is essential, personal contact coupled with service. The industrialist should be encouraged to consult his gas undertaking as a matter of course on problems of fuel utilization.

We have mentioned cheap gas of satisfactory quality. One can do a very great deal with gas in industry when, as in Aberdeen, it is—or was under normal conditions—supplied at less than 4d. a therm and care is taken to apply it efficiently. Mr. Milne referred specifically to his experiences in the use of gas for overhead heating—he is most enthusiastic about this method—for central heating in the more orthodox manner, for core drying, pipe bending, and so on; and, of course, the number of small-scale uses, exemplified in the Paper by reference to the blacksmith's shop, is legion. And with gas at round about 4d. a therm to domestic consumers the field opened up is vast. Actually Mr. Milne did not confine himself to industrial usage, though this was the major theme of his contribution, and in one direction only, that of water heating in the home, what has already been accomplished heralds great expansion after the war. It is significant that in the last three municipal housing schemes undertaken gas has been installed as the sole means of water heating, to the satisfaction of the housewife and the Housing Department, which Department, through the efforts of the gas undertaking, has had its interest thoroughly aroused in the use of gas in the post-war home.

New Oil: New Coal

Close on the heels of the announcement by the Ministry of War Transport of the closing-down of the producer gas scheme—on the history of which we commented in these columns last week—a scheme designed to supplant yearly 100,000 tons of imported oil is the news released of the production from an English oilfield, the location of which is a closely-guarded secret, of 100,000 tons of oil a year, or 26,000,000 gallons. During the war period a total of 78,000,000 gallons has been produced. In comparison with the country's requirements of oil—the peacetime import of 1938 was 568,000,000 gallons—the production is small, but it indicates a fine technical achievement representing the culmination of painstaking work. When the war broke out 20 areas in Great Britain had been tested for indigenous oil by the Anglo-Iranian Oil Company through its subsidiary, the D'Arcy Exploration Company, but total production was not more than 967 tons. By 1941 increasing activity by U-boats called for the most intensive effort to bring to the surface every ton of oil in this country, and the target optimistically set by Mr. Geoffrey Lloyd, Petroleum Secretary and Chairman of the British Oil Control Board, and now achieved, was exactly four times the then output. It is stated that the venture is now a commercial proposition.

Then, on Friday last, Mr. Robert Foot, Chairman of the Mining Association, spoke of "a very great development in the Shropshire coalfield." One pit, he said, was undergoing considerable development, and would find its way into a virgin coalfield where there were literally hundreds of years of untouched coal; and he added that the enterprise would carry the Shropshire coalfield to the Cannock Chase border. The news is very encouraging; it would be more encouraging if the labour situation in the mining industry—we mean the reluctance of young men to become miners—was more satisfactory. As a matter of fact, Mr. Foot said how worried he was that so many miners' sons were going out of the industry.

Personal

Mr. A. J. WEST and Mr. C. H. PEARSON have been appointed Joint General Managers of the Gas Meter Division of the Parkinson & Cowan Group of Companies.

* * *

After 42 years' service with the Tenby Gas Consumers' Company, Ltd., Mr. F. G. BROOKMAN, Engineer and Manager, is retiring at the end of the year. To honour his services to the Company the Directors are electing him to a seat on the Board.

Obituary

Lieut. J. B. LIVESEY, only surviving son of Mr. and Mrs. David T. Livesey, has been killed in action. Mr. David Livesey is Engineer and General Manager to the Doncaster Gas Department.

Letters to the Editor

Complete Gasification

DEAR SIR,—It may well be true, as Mr. Helps claims, that by gasifying instead of selling our coke the saving of some two-thirds of our coal bill would substantially exceed our loss of net revenue on coke and on two-thirds of our chemical by-products. This saving would be realizable only if coke were identical with coal as a raw material for gas-making. This is not the case. Other costs are involved as a result of which gas made from coke and distributed as town gas has hitherto been more expensive in final cost to the user than that obtained by the normal processes by reason of various charges which Mr. Helps has omitted from his account.

Clearly the economics of production are influenced by the price of coal relative to the price obtainable for coke and chemical by-products, and it is yet too early to say what these may be after the war. If the development of cheap gas fails to be matched by an increased demand for coke it may well pay to use coke rather than coal as the source for some of this additional gas output.

But all this is common ground, and Mr. Helps is preaching to the converted. Engineers have long looked with interest and have encouraged research into means for increasing the gas/coke ratio. Work is active, and the economics of various processes have been, and are being, carefully studied. When works extensions can be undertaken after the war the additional plant can be designed to make gas only or to convert surplus coke to gas *if* the circumstances then operating render this desirable.

Hitherto coke has more nearly formed an adequate substitute for coal used as a fuel—*e.g.*, in boilers—than when used as a chemical substance for gas-making. Hence, besides being now fruitless, it is incorrect to suggest that the past and present practice of the Gas Industry has been and is grossly inappropriate to current needs, and that in consequence the Gas Industry is threatened by "immediate decline" or is in "parlous condition." Such distortion of the facts is misleading outside the Industry, confuses members of the Industry, and fails to do justice to the consideration long given to the points at issue.

Wimbledon. Yours faithfully,
Sept. 20, 1944. C. A. MASTERMAN.

The Salaries Question

DEAR SIR,—My attention has been drawn to the letters which appeared in the "GAS JOURNAL" on Aug. 16 and 30 referring to the problem of salaries in the Gas Industry.

The Association of Scientific Workers has had much experience this past few years in negotiating on behalf of scientific and technical workers in most fields, including those employed by local government bodies and Government Departments. This experience supports the view that there will be no improvement for the employees in those industries which remain unorganized, and it is futile to lament the low salaries being paid in the Gas Industry in the hope that the consciences of those who control the Industry will be stirred. It is a fact that many employers are prepared to pay to qualified scientists and technicians lower salaries than their skilled or semi-skilled manual workers would accept. The A.Sc.W. has been able to make a considerable change in this practice wherever it has received the support of the employees in individual firms or in whole industries.

For example, this state of affairs no longer exists in the engineering industry, where the growth of the A.Sc.W. has been particularly marked. To-day the scientific and technical staffs in that industry enjoy the right to negotiate with their employers on all questions affecting their conditions of employment through the medium of the Agreement reached between the Engineering and Allied Employers' National Federation and the Association of Scientific Workers.

The Association of Scientific Workers, which is affiliated to the T.U.C., caters for engineers, chemists, and metallurgists in all industries, in addition to other scientific workers employed in Universities, research establishments, and the medical services.

Yours faithfully,
T. AINLEY,
Sept. 20, 1944. National Organizer.

Joint Industrial Council

The Twenty-fifth Annual General Meeting of the National Joint Industrial Council for the Gas Industry was held at the Waldorf Hotel, Aldwych, on Friday, Sept. 15, presided over by Sir David Milne-Watson, Bt.

One of the items on the agenda was the appointment of a Chairman, and Sir David stated that he had had the honour of being Chairman of the Council ever since its inception in 1919, 25 years ago. He felt that among the many good things that had fallen to his share this honour was the greatest, because it showed that he had had friends among both the employers and the workers. During all the time he had been Chairman he had done his best to be fair-minded. He now felt that the time had come for him to relinquish the Chairmanship, which he did with a most cordial feeling towards the Council, which had grown up with him. He had enjoyed the work, and had had absolutely loyal and faithful support from both sides. In asking to be relieved of the work, he would like to suggest that it would be appropriate to appoint Mr. Charles Dukes, C.B.E., the Vice-Chairman, to the Chairmanship. It was the wish of the Employers' Side that he should be asked to accept the office, and he could not imagine a better Chairman. He therefore had much pleasure in proposing that Mr. Charles Dukes should be appointed Chairman of the N.J.I.C. for the ensuing year.

Mr. Williamson expressed the regret of the workers' side at the retirement of Sir David from the Chairmanship, and thanked the employers' side for their gesture in proposing that Mr. Charles Dukes should become Chairman for the ensuing year, which he had pleasure in seconding.

Alderman W. Thorne, M.P., also expressed satisfaction at the employers' proposal.

Mr. Dukes thanked members for the honour bestowed on him, which he felt very deeply. He would do his best to emulate the fine example set by Sir David, and could only hope that at the end of his period of service, whatever it might be, he would have gained the confidence and respect of the members of the Council in the same way that Sir David had done. The National Joint Industrial Council for the Gas Industry was undoubtedly a model Council and was spoken of very highly in industrial circles, and he felt that this was in no small measure attributable to the way in which Sir David had guided its affairs, and the wise counsel he had given when differences of opinion might perhaps have created a more hostile attitude. The period between the two wars, during which the Joint Industrial Council had developed, had been one of great difficulty—probably the most difficult in the history of the country. It could not be claimed that the Council was the "last word" in joint machinery dealing with industrial matters, but it was nevertheless a fact that it did represent an idea—if not the ideal—that would have to be developed in the years lying immediately ahead. As for Sir David, a more appropriate occasion would be chosen to say what all felt in their hearts and minds, and to honour him for the way in which he had presided over the meetings of the Council, and had set before them the wonderful example which it would now become his task to emulate. In thanking the members for the honour paid him, he could only say that he would try to follow the precedent created by Sir David.

Leamington's Lighting

By Sept. 17 the Leamington Priors Gas Company got well over 600 lamps alight out of a pre-war total of 1,600.

The lanterns were painted black to the bottom of the single mantle, colour-washed blue from the bottom of the lantern up to where the line at an angle of 60° with the horizontal measured from the mantle cut the side panes, and then colour-washed with a mixture of light blue and white to within 1 in. of the black band at the top.

To make the best possible use of all labour available in the town, the Corporation undertook the painting work and the Gas Company attended to reducing the number of nozzles in use and other fitting work.

The Company is getting more lamps alight every night.

Diary

Oct. 6.—Junior Institution of Engineers: Informal Meeting, 39, Victoria Street, S.W. 1, 6.30 p.m.

Oct. 7.—Yorkshire Junior Gas Association: Annual Meeting, Great Northern Hotel, Leeds, 2,30 p.m.

Oct. 11.—Southern Association of Gas Engineers and Managers: General Committee, 11.30 a.m.; Autumn Meeting, 2.30 p.m.; Grosvenor House, Park Lane, London.

Oct. 12.—B.G.F. Domestic Heat Services Committee, Gas Industry House, 2.30 p.m.

Oct. 12.—Institute of Fuel: Annual Luncheon, Connaught Rooms, 1 p.m. Presidential Address by Dr. E. W. Smith, C.B.E., followed by Melchett Lecture by Dr. J. G. King, O.B.E., 2.15 p.m.

Oct. 27.—Manchester District Association of Gas Engineers: Autumn General Meeting.

A Government Housing Manual

The Housing Manual, 1944,* which has been prepared by the Ministry of Health and the Ministry of Works and sent to all local authorities in England and Wales, gives technical guidance to local authorities, architects, builders, manufacturers, and others on the lay-out, planning, construction and equipment of permanent houses to be built under the Government short-term housing programme covering the first two years after the end of the war in Europe.

In general, the standards recommended in the Manual are those proposed by the Design of Dwellings Sub-Committee of the Minister of Health's Central Housing Advisory Committee. The great majority of houses built by local authorities under the short-term programme are likely to be of the three-bedroom type. The Manual discusses general principles of planning a three-bedroom house.

The Manual states: "The way of living in the house depends on the arrangements for cooking meals; these arrangements will also indicate the fuel or fuels to be used, and to a large extent the nature and arrangement of the fuel-burning installations and appliances. On the other hand, the availability of fuels or the choice of fuel, where there is a choice, will also influence the way of living in the house and the types of accommodation to be provided.

"The houses built by local authorities in the years between the wars were originally planned on the assumption that cooking and water heating would be done by a coal fire in the living room. These houses had a large living room in which meals were to be cooked and eaten, and a scullery which was deliberately kept to a size that would discourage its use for anything more than the preparation of food, washing-up, and laundry.

"With the extension of public services, electricity and gas became increasingly used for cooking and, because it was convenient to have the cooking stove within easy reach of the sink, the electric or gas cooker was usually placed in the scullery, which then became in every sense a kitchen. Meals were still intended to be eaten in the living-room.

"On the other hand, when the cooking equipment had been transferred to the kitchen, many people found it more convenient to take their meals—or at least breakfast and possibly the midday meal—in that room, since the serving of the meals in the most direct way possible from the cooking stove to the table greatly reduces the labour of housekeeping. Moreover, there is now a very general desire to have some living space free from constant interruption of meals, and in many households the number of times in the day when a meal has to be provided for some member of the family is such that it becomes practically impossible to keep in any kind of order a living room used for the service of meals.

"We thus have three ways of living in the house, each revolving round different arrangements for cooking and serving meals. Each will suggest its appropriate house plan, with variations determined by the presence or absence of separate dining spaces, sculleries, or wash-houses."

* H.M. Stationery Office, York House, Kingsway, W.C. 2, price 2s., post free 2s. 3d.

The Ministry of Fuel and Power has authorized an increase of 1d. per therm in the price of gas supplied by the Wandsworth and District Gas Company.

Watford Food Show

The display of the Watford and St. Albans Gas Company at the annual Watford Food Show held at the Town Hall. Many enquiries were received in connexion with this exhibit, which included a display of cooked foods.

Non-Aerated Gas Burners

The following written contributions were made to the discussion on the Paper, "Combustion Characteristics of Town Gas," given to The Institution of Gas Engineers by Messrs. G. H. Fuidge, J. R. Dewhurst, and B. Pleasance—see "JOURNAL" of June 7.

Mr. **D. Chandler** (South Metropolitan Gas Company): It is to be hoped that the Paper will stimulate thought and produce action to the end that a rational procedure will be adopted by the Industry in connexion with the combustion of gas. From the point of view of utilization, the Paper invites comment. In the summary it is stated that "The results show that the combustion diagram is affected very considerably by the design of the burner." This is true, and it is because of the number of different designs of bunsen burners in existence that the problem is complicated. In the case of non-aerated gas burners the number is small; in fact, for gas fires and gas cookers it can be reduced to one or two designs, and the problem thus simplified.

Greater flexibility in the character of the gas is allowed by the use of the non-aerated-gas type of burner. They are not affected, within reasonable limits, by normal district variations of pressure or alterations of the calorific value of the gas. To quote an example, 1,000 flueless gas wash-coppers with burners of this type were fitted in a local authority's housing estate in 1937/8. The calorific value of the gas supplied to the estate was reduced between 1939 and 1944 from 560 to 530. The writer was informed recently that maintenance was "small to *nil*." The maintenance of the wash coppers was undertaken by the local authority.

"It is realized," state the Authors later in the summary, "that in certain cases, as in the gas cooker, the need for the burner to fit into a particular space may make it difficult to employ the most efficient type." This is a statement which the writer finds hard to reconcile with modern practice. It implies that the oven space having been determined, the burners are poked in as an afterthought. This is not the practice of cooker designers worthy of the name.

The Authors' deductions, based on results obtained from the six models shown on p. 8 of their Paper, seem to suggest that it is a formidable problem to produce simple and satisfactory gas burners. This is noteworthy in view of the statement, "the ultimate performance of any appliance depends both upon the design of the burner and on the characteristics of the gas." The position is made more involved by the fact that the number of patterns of burners in use is legion.

The Authors affirm in Section II, "It will be agreed that with the greatly increased variety and complexity of appliances the Gas Industry can no longer expect its consumers to make adjustments to compensate for variability of the commodity; it must ensure that consistently good service is obtained without attention to the appliances by consumers." With that assertion all will agree, but is it not strange that many in the Industry still fail to realize that the practical solution of the problem is bound up with the type of gas burner used, and that there is a solution which, translated into practice intelligently, will do much to achieve the "consistently good service" desired? Most certainly it will do away with any necessity for consumers to attempt "to compensate for variability of the commodity," a series of operations the technique of which they do not understand.

The hope is expressed "that the information in the Paper will, in some small degree at least, help the Gas Industry in its task to provide the best possible service to the public." That pious hope suggests that the time has come for the Industry to shake itself free of the obsession that only gas burners constructed on the bunsen principle are suitable for domestic appliances. Is it not that obsession which hinders the realization of the hope?

Section VI, in which the Authors give the results of their examination of certain characteristics of the simpler type of gas burner, in which all the air required to burn the gas is supplied at the point of combustion, is of particular interest to the writer because it amplifies earlier work on the behaviour of industrial jets published in a (confidential) report to the Industrial Gas Centres Committee, which was circulated in March, 1943. Some of the statements in the Paper may mislead quite unintentionally those whose knowledge of the practical application and functioning of this type of burner is scanty. In parenthesis, is it not incorrect to describe this type of burner as non-aerated? It is the gas which is aerated in the bunsen burner, and therefore the description of the simpler burner should be non-aerated-gas burner.

It is noteworthy that the Authors are at pains to point out that "the modern types are so designed that the gas issues through a small orifice at full, or nearly full, district pressure; the resultant rapid movement of the gas enables it to entrain sufficient air to render the flame nearly non-luminous." This statement should be amplified, because the kind of gas made to-day also contributes to the character of the flame produced by a modern heating burner of the non-aerated-gas type.

It is stated that "modern burners are constructed in such a way that when they are operated at normal pressures a considerable proportion of air is entrained by the gas, and it is only at low pressure that these flames are really non-aerated." Is there such a phenomenon as a "non-aerated" flame? What actually takes place is that at low efflux velocity the air required to burn the gas is supplied by diffusion, and for that reason flames may be a little luminous when the pressure is reduced on turning down the tap. That I believe is the correct explanation.

Practical experience has shown that "sooting" will not occur provided proper care is taken in the selection of jets of the right type and size, and in their disposition in relation to the appliance in which they are to be fitted and used. It is noteworthy that when the South Metropolitan Gas Company, some eight years ago, first began to use this type of burner in cooking ovens, straight coal gas from which benzole had not been extracted was supplied to the district; the calorific value then, and up to the outbreak of war, was 560 B.Th.U. per cu.ft. and the density about 0.400. Burners fitted to gas ovens did not give the slightest trouble, and equally satisfactory results were obtained on the hotplates of the cookers. Of course, the boiling burners were of an entirely novel construction, and it was the intention at that time to proceed with practical development of these burners, despite the fact that the removal of the benzole had not been envisaged. However, it is only right to add that the use of these burners has been greatly facilitated by the extraction of a considerable proportion of the condensable hydrocarbons.

Absence of noise the Authors state "constitutes one of the advantages of non-aerated burners in use in domestic appliances, since no bunsen burner gives a silent flame, however well it is constructed. Hence it can be considered that for these burners silence is a criterion of satisfactory combustion." If by "satisfactory combustion" the Authors mean complete combustion, then the statement requires to be qualified, for there is no inherent relationship between inaudible combustion and its completeness.

It is important to know that a noisy burner of the non-aerated-gas type can be the result of several causes. Excessive gas pressure is one; turbulence in the flow of the gas is another and is often produced by badly-made gas taps. It is common experience that when some taps are turned partially on noise is produced or intensified. It can also be produced by too small gasways in the supply pipe and burner chambers, by sharp angles and rough or sharp edges disturbing the streamline flow of the gas. The absence of noise in itself is not necessarily a criterion of satisfactory combustion, except in the sense that it does not irritate the user of the appliance when it is working. Conversely, noise is not a criterion of unsatisfactory combustion in the sense of incomplete combustion.

The illustration of the No. 000 industrial burner jet shows a gauze screen as part of the burner. This is unnecessary in jets with such small orifices.

In the list of advantages there is at least one more to be added—namely, "A small range of standardized, accurately-made jets will meet all the requirements of domestic appliances."

Referring to the list of disadvantages:

(1) The industrial burner jets are somewhat fragile and may, in some cases, be appreciably more costly than a bunsen burner. This is not borne out in practice.

(2) The maximum working pressure for all but the smallest jets is of the same order as the normal district pressure. Thus, to ensure satisfactory combustion a governed gas supply is almost essential.

A governor is desirable in many cases, but it is not "almost essential" to ensure "satisfactory combustion."

If one asks what will be the outcome of work of this nature, then, surely, the answer can only be the ultimate production of simple, consumer-proof appliances.

The Gas Industry has it in its power to advance in the field of domestic gas usage, provided it attacks vigorously the problem of service to its millions of consumers through the quality of the gas supplied and the simplicity of the appliances provided to burn it.

Dr. **N. Booth** (Gas Research Board): Both sections of the paper will be of great value in consideration of the relative flexibilities of different gases and of the behaviour likely to be experienced on different types of appliances. The results obtained with gases of 425 and 500 B.Th.U. show that flexibility is greatest with gases rich in methane, carbon monoxide, and inerts. It is interesting to note that such gases have high densities and low flame speeds. It is also concluded that if a high degree of flexibility in manufacture is desired, a gas of moderate calorific value is preferable to one of high calorific value. It would be interesting to know whether this conclusion would apply to gases of higher and lower calorific value than those at present made. A point of some importance, which is not mentioned by the Authors, is whether the gases employed were completely burnt over the whole range of possible use.

With regard to the section on non-aerated flames, the information obtained is of great interest, and we are indebted to the Authors for discussing in Appendix I the reasons which may underlie their observations. A very large number of factors enter into combustion on non-aerated burners, and to attempt a quantitative explanation of observations made on such burners is an impossible task in the present stage of our knowledge. Much information is required on the modifying effect of the flame on conditions of gas flow, and this modifying influence may well be different in magnitude for different gases. It is to be expected that, in the course of time, investigations such as those of Professor Townend and his collaborators will provide sufficient basic information about aerodynamics of gas-flow for at any rate a quantitative explanation of the results given in this Paper to be provided.

The air required for combustion of the gas in the case of non-aerated burners is obtained partly by entrainment and partly by

(*Concluded on p. 415*)

Infra-Red Drying*

Some Experiments and Results with Gas-Fired Equipment on High-Speed Baking of Paint Finishes and Other Drying Processes Using Radiant Heat

By F. L. ATKIN, M.I.Mech.E.,

Industrial Research Laboratories, City of Birmingham Gas Department

(*Concluded from p. 374*)

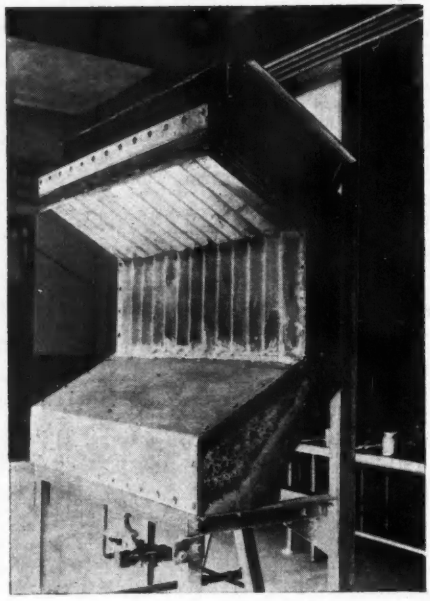


FIG. 9.—*Photograph of New Type of Infra-red Tunnel showing Corrugation.*

8. Experimental Work

With the equipment described, a certain amount of investigation of the factors influencing rapid drying by radiant heat was carried out and is described below. Methods of temperature measurement are important and are discussed in the Appendix.

Influence of the Emissivity Factor.

It is very necessary in carrying out any comparative tests to standardize the character of the surface. Fig. 12 shows the result of treating a metal surface as received either by polishing or painting one coat matt black. In discussions on heat transfer problems the importance of the emissivity factors is understood, but this is emphasized by the comparative curves, and, therefore, in all the pertinent tests mentioned in this Paper, matt black surfaces have been used. In the course of these experiments, it was noticed that the eye was not a good comparator of emissivity factors when subjected to long-wave radiation.

Influence of Thickness of Metal.

Table II gives the time to reach 220°F. for different thicknesses of metal. A popular misconception exists that by some magical means the infra-red rays heat up the paint without heating the metal. This idea is usually coupled with the "inside-to-out" theory, implying that the paint is heated from the surface of the metal outwards. The drying of paint from the inside surface is probably true whichever method is used, since if heat is applied to a painted surface at such a rate as to set the outer skin, solvent trapping may take place, causing "blistering" and "pinholing."

A theoretical argument may be applied that if the paint film is selectively transparent or translucent to a given wavelength, the rays penetrate to the surface of the metal which is selectively reflective to the same wavelength; consequently the paint dries without the metal being heated, but such an ideal combination is difficult to imagine in practice.

It is, therefore, generally acknowledged that the metal surface covered with paint must be at or above the paint-drying temperature. For thin metal sheets, the conductivity of the metal is so great that temperature differences across the thickness are insignificant. This has been proved by heating up a plate painted on one side only, first exposing the painted surface to the radiation, and then exposing the unpainted surface. Both methods produced identical drying times.

It is possible that for large thicknesses, the surfaces can be irradiated at a greater rate than the heat abstracted from the surface by conduction. It has been stated that paint may be stoved on metal of more than ½ in. thickness without the metal which is remote from the source being heated to the paint-drying temperature.[15]

Drying of Dissimilar Shaped Articles.

Since metals of varying thicknesses require different times to acquire the same temperature, and since this is reached on a rising gradient, it follows that if a composite article of different thicknesses is painted with a medium which has a narrow latitude between drying

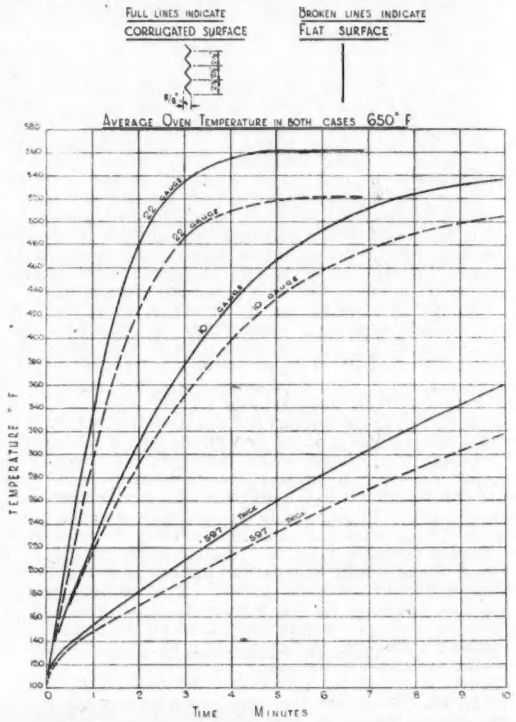


FIG. 10.—*Curves Showing Difference between Corrugated and Plain Surface.*

and discoloring and is subjected to radiant heat, spoiling will occur on the thin section.

In practice, a margin exists depending on two things :

(1) The relative proportion and position of thick and thin sections, as in certain cases the thicker section can "hold back" the thin section by conduction.

(2) The latitude of the paint. This applies particularly to the lighter or pastel shades. (One of the best contributions to radiant heating can be made by the paint manufacturers producing paints of wide latitude.)

Thickness of Paint Film.

For a given thickness of metal the time to dry the film varies considerably with the thickness of the paint film. A test plate was coated with paint which had been thinned down and the time to dry was noted. On coating a similar test panel with the original unthinned paint, the drying time was increased by three times. This point will be dealt with when discussing Sprayed *v.* Dipped work.

Effect of Sprayed and Dipped Work.

It is much simpler to dry sprayed work than that which has been dipped, unless special methods of centrifuging the latter are adopted. Dipped work leaves a tear or blob which may be reduced by cutting

* Paper to the Midland Junior Gas Association in Birmingham on August 24, 1944.

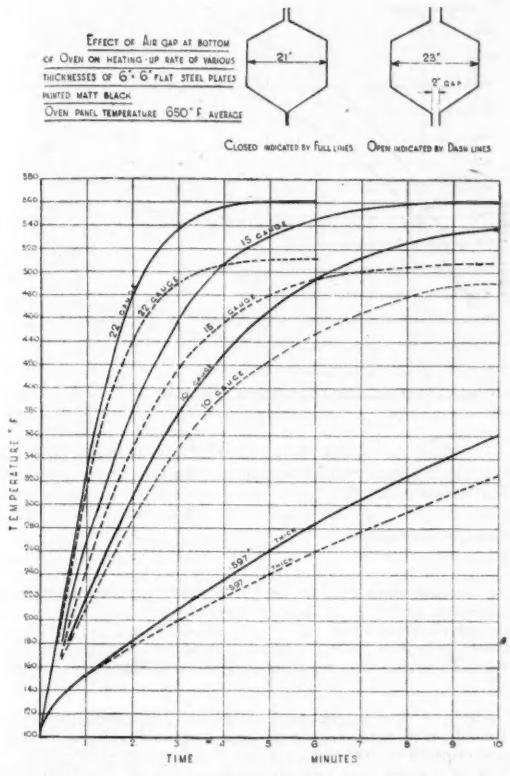


FIG. 11.—*Curves Showing Effect of Air-gap at Bottom of Tunnel.*

down the viscosity with thinners, a point being reached, however, when the paint loses its obliteration power. From a consideration of the drying of different thicknesses of paint film, it will be understood that the blobs will not be dry when the rest of the surface is finished. If the time is extended to dry the blobs, the remainder of the surface may pass the threshold of spoiling, but if, on the other hand, the emitting source is reduced in temperature, the total time of drying may be increased, and the advantage of radiant heating may be lost. This brings the convection oven into its own, as the operating temperature of this type of unit is fixed at not greater than the necessary drying temperature.

In certain cases the complete drying of the blobs can be neglected, provided the work is not handled for some hours, as with many types of paints the blobs will dry off in the air. Again, the paint manufacturers may be able to solve the problem by producing a paint which will drain without tears or blobs.

Type of Paint.

The classification of paint probably has the greatest significance on drying time. The various types have been described elsewhere, but owing to differences in drying times of paints of the same group, it is not possible to be dogmatic. The Author is convinced that the only satisfactory method of determining these times is by actual experiments with articles and paint.

Generally the synthetic types of paints having a nominal drying temperature of 250°F. are the most suitable for radiant heating, as they have the shortest drying time.

Colour of Paint.

The pigmentation of paint affects the drying times, the differences depending on the nature of the emitting source, and it has been shown that by virtue of the displacement of the peak wavelength of the medium temperature gas-fired panel, the variation in drying times between colours is reduced.[16]

The problem is complicated by the fact that the pigments used in paints have different physical properties apart from their colours.

Fig. 13 gives curves showing the effect of colour on heating rates. It should be clearly understood that these curves are applicable only to particular paints and a given set of test considerations as noted. In order to demonstrate the difference, it will be seen that the oven panel temperature was lowered to 460°F.

9. Tests on Various Articles and Processes

A considerable number of experiments for about 60 or 70 interested firms have been carried out, the range of articles treated being given in Table III. It will be noticed that there are a number of special jobs as distinct from paint and varnish.

TABLE III.—A SELECTION OF ARTICLES ON WHICH EXPERIMENTS WITH RADIANT HEATING HAVE BEEN MADE.

Ammunition Boxes. Eyelets. Vacuum Flasks. Car and Lorry Bodies. Cylinder Heads. Petrol Pumps. A.R.P. Lamps. Cycle Lamps. Cycle Fittings. Brake Linings. Petrol Can Labels. Window Frames. Construction Steelwork for Prefabricated Houses. Cycle Saddles. Ceramic Materials. Cash Boxes. Filing Cabinets, &c. Fruit Cans. Springs. Steel Bins. Zeolite (dehydration of). Glass Mirrors (backing). Plastic Moulding Powders and Preforms.

Paint Drying.

A considerable amount of experimental work on paint drying has been carried out, and a recital of times and temperatures could be given. The various factors influencing the time of drying have already been noted, and bearing these in mind it may be said that with the normal types of paint formulated to suit rapid drying, used on sheet metal articles, the times vary from 50 seconds to a maximum of 5 minutes. Heavier sections will, of course, take longer.

Drying of Ceramic Materials.

A series of tests was carried out on the drying of small ceramic articles about 3 in. long by ¼ in. diameter. These articles are usually dried in 5 hours by electrically heated air blown counter-current to their passage through a conveyor type stove, thus producing a high humidity condition at the initial drying stage. Controlled humidity of this type has been accepted hitherto as the "correct" method of drying clays, timber, &c., thus avoiding the "case-hardening" effect. It was found possible to dry satisfactorily the articles mentioned above in less than ½ hour in the infra-red tunnel. The method of testing was to weigh and subsequently heat 12 samples in the experimental tunnel. Three specimens were withdrawn every 15 or 20 minutes, and allowed to cool before weighing. They were considered to be dry when constant loss of weight was observed.

Fig. 14 shows the method of supporting the samples, and the following Table IV gives the final summary.

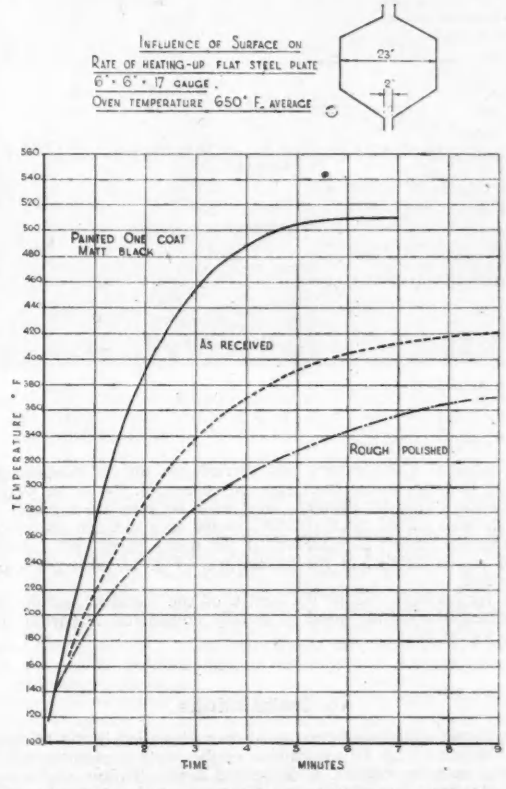


FIG. 12.—*Curves Showing Influence of Character of Surface on Heating-up Rate.*

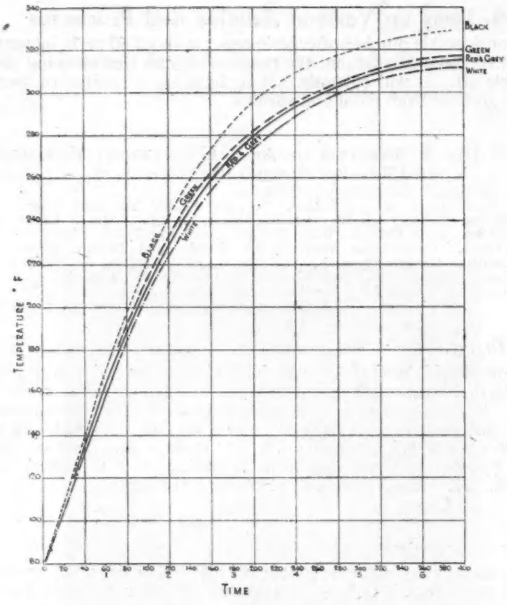


FIG. 13.—*Curves Showing Effect of Colour on Heating-up Rates. 18 I.W.G. Steel Sheets, dimensions 6 in. × 3 in.*

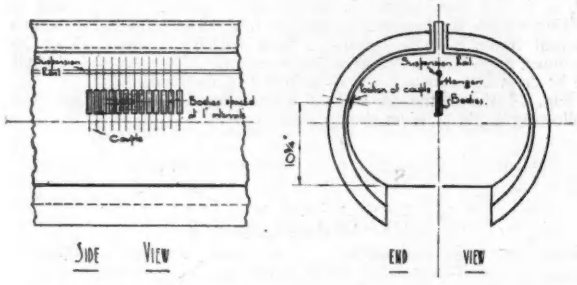


FIG. 14.—*Drawing of Method of Carrying out Tests on Ceramic Materials.*

TABLE IV.

Test series.	Panel temperature (°F.).	Time to reach constant loss of weight.
1	315	After 2 hours.
2	445	,, 1 hour.
3	500	,, ½ ,,
4	560	,, ½ ,,
5	588	,, ½ ,,
6	622	,, ½ ,,
Time to dry by hot air		5 hours.

Metal Panels on Wood.

An interesting experiment was carried out on the heating of a painted 16-gauge metal sheet screwed to a 1 in. by 1½ in. wooden framework. This arrangement was made to simulate a motor car body constructed of metal panels fastened to a wooden framework. One thermocouple was attached to the metal panel and a further couple was embedded in the framework. Fig. 15 gives particulars of the test.

The temperature rise at the centre of the wooden member was rather remarkable, as wood is usually considered a partial non-conductor of heat.

10. Installations

One of the earliest radiant tunnel ovens installed in the Midlands is that shown in fig. 16; a drawing of the plant is given in fig. 17. This was made by Messrs. F. J. Ballard & Co., Tipton, and is fixed at the Midland Metal Spinning Company, Ltd., Wolverhampton. In the following table are the results obtained with one tunnel only.

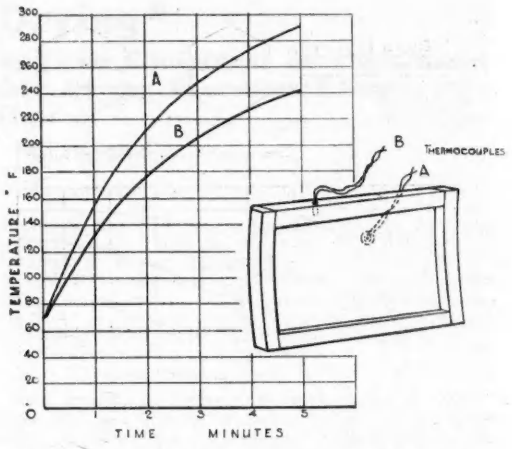


FIG. 15.—*Tests on Metal Panel Screwed to Wooden Framework. Painted 16 Gauge Panel Fastened to Wooden Framework. Oven Temperature 556° F.*

Time of irradiation	5 mins. 10 secs.
Total time in stove	8 mins. 37 secs.
Output per hour	1,000 articles.
Gas consumption	600 cu.ft. per hour (2.7 therms).
Heated length	9 ft.
Length of stove	15 ft.
Width of stove	3 ft. 8 in.
Temperatures	Panel 450/500°F.

To obtain a similar output a conveyor convection oven, 25 ft. long by 4 ft. 6 in. wide with a stoving length of 9 ft., and having a gas consumption of 400/500 cu.ft. per hour, would be required.

It will be noticed that two infra-red tunnels are installed in series on one conveyor line, the intention being to use the assembly for two-coat spraying and drying. After certain preliminary trials, unheated vestibules were added at the entrance and exit of the stoves, the object being two-fold, firstly to reduce the radiation and convection losses from the ends, and secondly to use the heat otherwise wasted as contributory heating. These have been very successful and can be strongly recommended for any similar plant.

Reference is made to the plant illustrated in fig. 6, which is per-

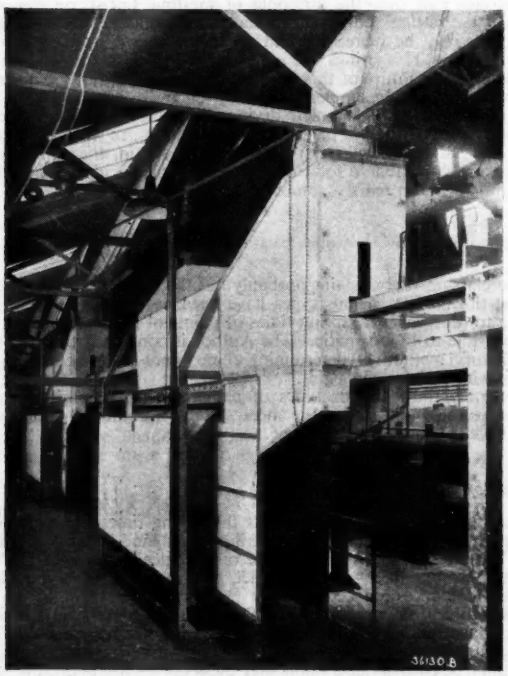


FIG. 16.—*Photograph of Infra-red Gas-fired Tunnels. (Courtesy of the Midland Metal Spinning Co., Ltd.)*

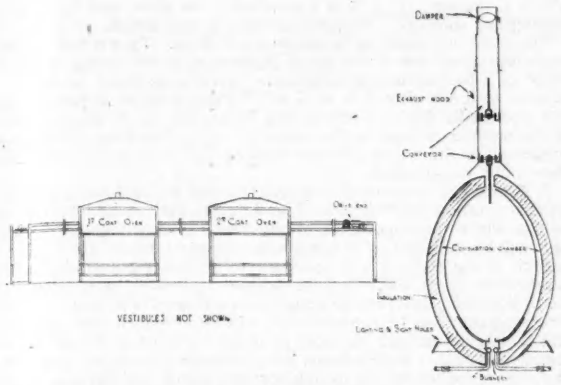


FIG. 17.—*Drawing of Infra-red Gas-fired Tunnels at Midland Metal Spinning Co., Ltd. General Arrangement of Ovens in Series and Cross-Sectional Elevation.*

forming the identical drying operation. Figs. 6 and 16, taken in conjunction, show how the same work may be done by quite different methods, probably due to improvization of plant to suit war production.

Drying of Petrol Cans.

An opportunity occurred to carry out tests on a gas-fired convection type conveyor oven used for stoving four-gallon petrol cans. A photograph of a can is shown in fig. 1. The results are compared with an electric infra-red plant stoving a similar output of cans. In both cases the vessels were coated inside and out with paint prior to stoving.

Details of Gas-fired Conveyor Convection Oven.

Stoving length: 32 ft. 6 in.
Oven body: 38 ft.
Overall length: 59 ft. 6 in.
Width inside: 12 ft.

Details of Electric Infra-red Plant.

Number of lamps in Preliminary Dryer :	4 banks of 36	= 144	= 36 kwh.
" " Main Dryer	22 "	36	= 792	= 198 "
	Total . .		936	= 234 kwh.

Comparison of Costs and Output.

	Gas-fired convector.	Electric infra-red.
Number of cans stoved per hour .	360 .	360
Time of drying	50½ minutes .	Prel. 1 minute. Main: 5½ minutes. Total 6½ minutes.
Energy used	1,340 cu.ft./hr. (6.03 therms).	234 kwh.
Cost of energy	3s. per 1,000 cu.ft. .	.65d. kwh.
Cost per hour	4s. .	12s. 9d.

Cycle Lamps.

Fig. 18 shows a radiant tunnel installed at the Coronet Camera Company, Summer Lane, Birmingham, for the drying of cycle lamps.

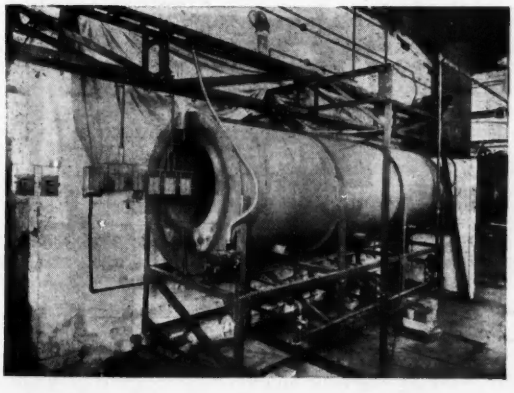


FIG. 18.—*Photograph of Infra-red Tunnel for Cycle Lamps. (Courtesy of the Coronet Camera Company and Aerospray Manufacturing Company.)*

The capacity of this unit is two gross of lamps per hour, the drying time being three minutes, with a panel temperature of 475°F. The average gas consumption is 240 cu.ft. per hour (1.08 therms), and this particular unit is fitted with thermostatic control operating on the panel surface temperature.

High Intensity Radiant Heating.

An interesting type of burner has been developed by Messrs. Keith Blackman, Ltd., in conjunction with the South Metropolitan Gas Company. It consists of a heat-resisting metal disc heated to a temperature of about 900°C. by a small high-pressure gas burner working at a pressure of 3 lb. per square inch. Fig. 19 illustrates

FIG. 19.

FIG. 20.

FIG. 19.—*High Intensity Radiant Burner, front view. (Courtesy of Messrs. Keith Blackman, Ltd., and South Metropolitan Gas Company, London.)*
FIG. 20.—*High Intensity Radiant Burner, back view. (Courtesy of Messrs. Keith Blackman, Ltd., and South Metropolitan Gas Company, London.)*

the front view and fig. 20 the back view, from which it will be seen that the products of combustion are evacuated through a central hole.

Burners of this type are shown in fig. 21 attached to a tunnel for paint stoving. It so happened that when the photograph was taken only small articles were passing through.

Figs. 22 and 23 show these units incorporated in a plant developed to dry paint on the inside and outside of circular metal cases weighing up to 75 lb. each. The time taken by this method is about one-tenth of the rate for forced air convection heating. The stove is fitted with a mechanically driven turntable to obtain uniformity of heating of the cases.

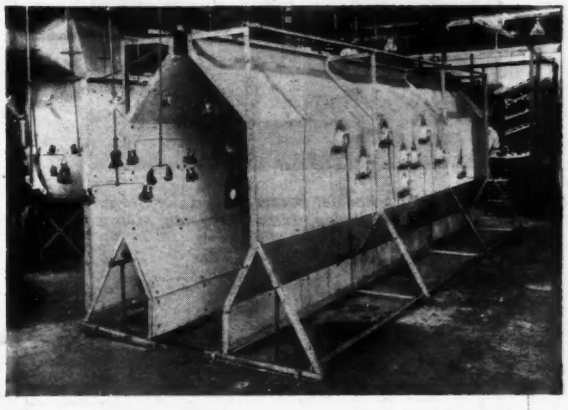


FIG. 21.—*High Intensity Radiant Burner, attached to Tunnel. (Courtesy of Messrs. Keith Blackman, Ltd., and South Metropolitan Gas Company, London.)*

Motor Car Body Finishing.

Interesting experiments have been carried out on the stoving of car bodies. Difficulties had been experienced when using electric infra-red tunnels, as the rays, which were highly directive, did not reach the boot and scuttle in sufficient quantity to dry them successfully. McCloud[17], in discussing experiments at the Ford Motor Company, Detroit, gives details of methods of the use of a multiplicity of lamps in the form of a clam-shell fitting over the body and travelling with the conveyor line; by this means the radiant heat was directed fore and aft. These clam-shells were used for the priming coat, but not the finishing coat, as the colours is use were susceptible to temperature differences.

Some scale-model bodies were constructed and passed through the gas-fired tunnel at the Industrial Research Laboratories of the Birmingham Gas Department, and these tests showed that it was possible to dry both the sides, top, front, and back with satisfactory results of drying time and evenness of colour finish.

To follow up these tests, an experimental section capable of taking full-sized bodies was designed. This was constructed by the Austin

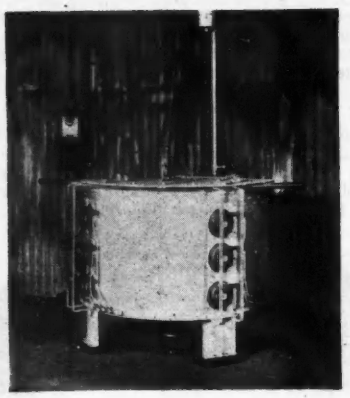


FIG. 22.—*High Intensity Radiant Burner on Circular Stove. (Courtesy of Messrs. Keith Blackman, Ltd., and South Metropolitan Gas Company, London.)*

FIG. 23.—*High Intensity Radiant Burner on Circular Stove. (Courtesy of Messrs. Keith Blackman, Ltd., and South Metropolitan Gas Company, London.)*

Motor Company. Fig. 24 is a drawing of the plant, and fig. 25 is a photograph showing a wartime car body in the tunnel.

The plant was made up in sections 3 ft. long. First a half section was constructed and a number of exploratory trials carried out, as a result of which certain modifications were made which were incorporated in a complete 3 ft. section. Further tests were then carried out, and finally the 15 ft. section was completed. A particular feature is the method of heating the panel by tiers of burners, which was suggested by the writer and has worked very successfully. Fig. 26 shows this construction.

A number of experiments are being carried out and are producing some interesting information. Fig. 27 gives the results of a typical test, in which the importance of convection is clearly demonstrated, as it will be seen that to obtain similar temperatures on the roof and bottom of the body, it was necessary to reduce the radiating panel temperature from 700°F. at the bottom to 450°F. at the top. It seems desirable, therefore, to design such tall tunnels so that temperature gradients can be achieved. It will also be seen that the boot and scuttle lag behind the sides in this test, which is by no means regarded as final. Vestibules are being introduced as shown in fig. 24, and the use of forced convection for temperature balancing is under consideration. There are other points which will not permit discussion at the present time, but fig. 28 indicates a suggested project. Utilization of the heated convection currents by an air recuperator is a possibility, and is incorporated in fig. 28.

11. Future Progress

It is certain that infra-red or radiant heating for drying operations has come to stay, but it is equally certain in the writer's opinion that convection ovens will still play an important part in such processes. It is incorrect to speak of infra-red displacing convection ovens.

The importance of convection in radiant tunnels cannot be over-emphasized. This has been mentioned in the paper in connexion

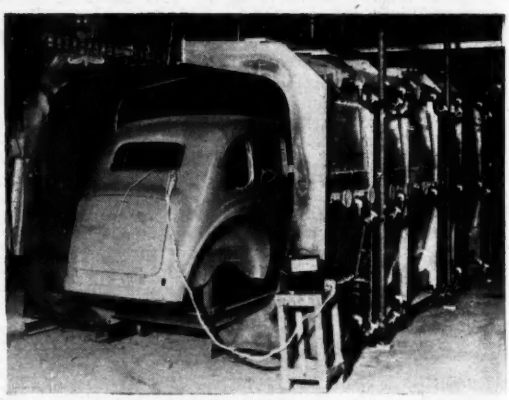
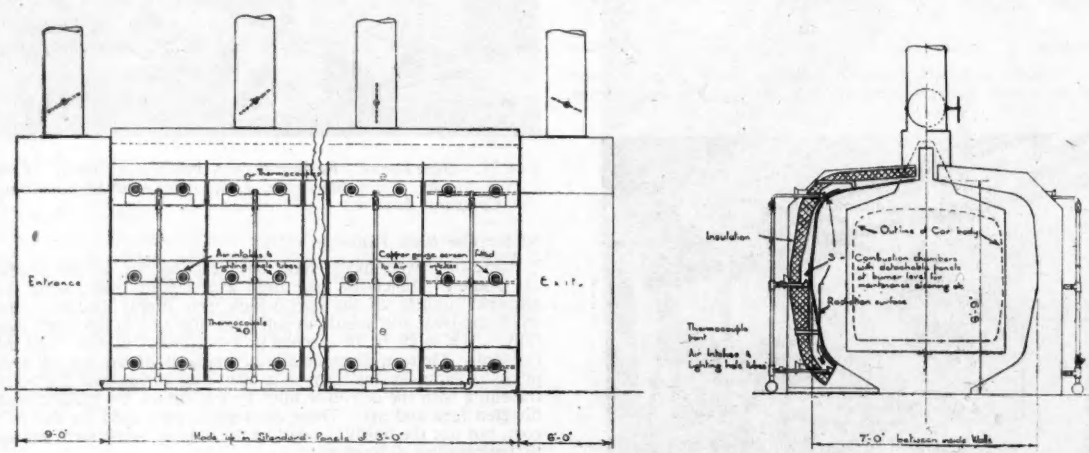


FIG. 25.—*Photograph of Experimental Plant for Tests on Car Body Stoving.*



Made from 18 swg Steel Sheets in 3'-0" long units complete with Bar burners etc
Units bolted together for any required length of oven
Max temperature on Radiation Panels 700° F
Burners Bottom bars Nº 7 Industrial Jets 170 off
Middle " Nº 4 " " 170 "
Insulation Slag wool or Magnesium Blocks

FIG. 24.—*Drawing of Experimental Plant for Tests on Car Body Stoving.*

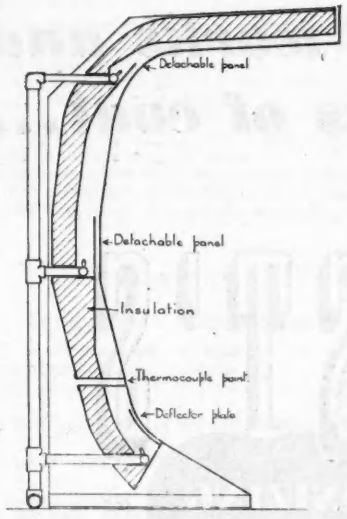


FIG. 26.—*Detail of Method of Heating Large Radiant Panel.*

with various processes, but as the majority of laboratory experiments are concerned with single articles, the effect is frequently overlooked.

In practice with a large number of articles passing through the oven, a considerable amount of convection currents arise producing air temperatures far in excess of those existing in laboratory plant, and these speed up drying times. It is, therefore, logical to utilize this heat, since the maximum drying efficiency is achieved when the oven air temperature is equal to the final finishing temperature. By utilizing this "waste" heat, a combined infra-red and convection oven could be used in one of two ways, either using the radiant-energy to boost the incoming articles and the waste convected heat for finishing, or *vice versa*.

For small work probably the simple radiant tunnel would be satisfactory, but for large plants the writer thinks future development will combine both infra-red and convection. No doubt a new name will be re-discovered for such a combination. A "Ray-vector" might suit such a hybrid!

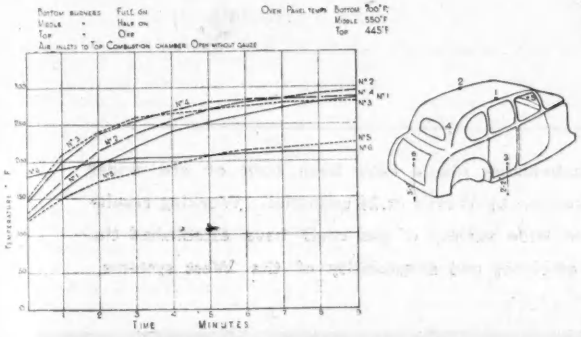


FIG. 27.—*Typical Test Results on Car Body Stoving.*

There have been many omissions of an interesting character from this Paper—the use of high temperature radiation, for example. This has many uses, and experiments have been made in connexion with soldering and similar processes. Sand drying, core drying, and dehydrating of various substances, including fruit and vegetables, are other problems. Tests have also been carried out on bakelite moulding powders and preforms with very encouraging results. Biscuit baking is also under consideration. Each of these problems could form the subject-matter of a separate study and case-history.

12. Conclusions

The following conditional premises for successful infra-red drying are suggested:

1. That a regular and controllable rate of progression of the articles through the infra-red tunnel can be arranged by mechanical or other means.

2. That for a given rate of progression the articles have approximately similar surface-to-weight ratios—*i.e.*, similar thicknesses.

3. That the production of sufficient quantities of articles to satisfy conditions 1 and 2 is an economic proposition.

4. That the articles stoved at the same time should be coated with the same type and colour of paint.

5. Although any type of stoving paint can be dried by radiant heat, the maximum advantage is obtained when paints are used which, although not necessarily formulated for infra-red drying, have rapid drying properties.

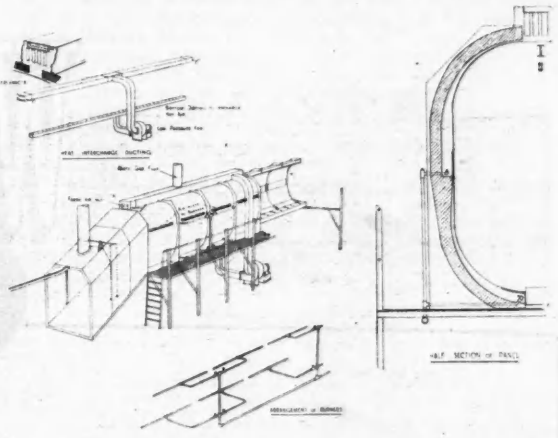


FIG. 28.—*Suggested Project for Radiant Tunnel with Circulated Air*

The above conditions are users' problems. There are, however, two other interested parties having problems, as follows:

Infra-red Equipment Manufacturers' Problems.

These have been outlined in the section on Future Progress, and the writer confesses to a feeling of disappointment that the recognized stove makers have not advanced more rapidly, the result being that the users have had to design and make, or have made, equipment which, while doing the work, has not the quality associated with first-class plant.

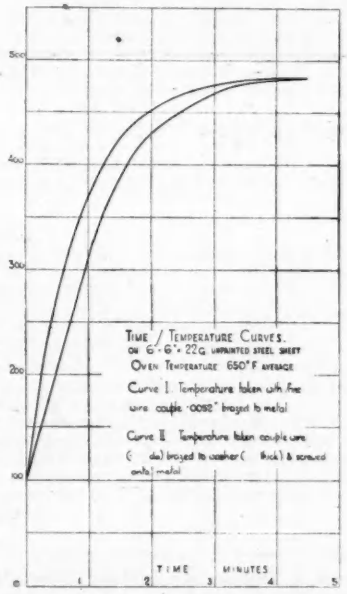

Time / Temperature Curves.
Curve I Temperature taken with free wire couple
Curve II Temperature taken couple wire
Time
Minutes

FIG. 29.—*Curves taken with Two Methods of Temperature Measurement. In Curve II the temperature was taken with couple wire 0.025 in. dia., brazed to washer 0.045 in. thick and screwed on to metal.*

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Paint Manufacturers' Problems.

There are no doubt many points to be solved by the paint manufacturers, but as far as the subject-matter of this Paper is concerned, the following seem important:

(*a*) Paints formulated to give a wide latitude between drying and spoiling. In mentioning "spoiling" it is intended to include the difference in shades of the lighter and pastel colours, which is obtained due to positional variation of the article in the tunnel, and the variation of thickness of same.

(*b*) Dipping paints which will dry without blobs or tears while retaining their obliteration properties, and will drain off quickly, thus avoiding long travel between the dipping and entry to the stove.

APPENDIX

Temperature Measurement

The method of measurement of temperatures on metal sheets which are heated up quickly is important.

The true temperature recorded on a metal sheet will be influenced by—

(i) The thermal capacity of the hot junction and couple wires, and—

(ii) The conduction of heat away from the junction by the wires.

The variation from the true temperature will depend on the relative dimensions of the metal plate and the couple. The heavier section of plate will be less affected than the lighter section, for not only is the comparative thermal capacity greater than the couple, but also the rate of temperature rise is less.

A special fine wire couple, 0.0052 in. diam., was made up and calibrated, and brazed to the centre of a 6 in. by 6 in. by 22 I.W.G. steel plate. On the same plate and about an inch away was attached a special couple made of wires 0.025 in. diam., terminated by a washer 0.875 in. diam. by 0.045 in. thick, brazed to the hot junction. The assembly was heated in a radiant tunnel, and fig. 29 shows the results. It will be seen that with this particular combination there is an appreciable lag of the heavier gauge couple.

The handling of fine wire couples attached to articles which had to be pushed into the tunnel quickly was found to be tedious and difficult, and it was decided, therefore, to use the heavier but more practical thermocouple for carrying out such tests. It should be borne in mind, therefore, that there is a tendency for the smaller sections to show a rate of increase which is less than the true rate of temperature rise.

Acknowledgments

The Author wishes to thank Mr. A. W. Smith, C.B.E., General Manager and Secretary of the City of Birmingham Gas Department, and Dr. C. M. Walter, Engineer in Charge of the Industrial Research Laboratories, for permission to read this Paper.

It would not have been possible to prepare it without the help of many kind friends, among whom the writer wishes particularly to thank the following for supplying drawings and photographs:

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The Author is also grateful to Mr. H. R. Hems for the suggestion to write this Paper and to his subsequent encouragement. The assistants who carried out the detail tests, particularly Mr. L. V. S. Mann, are also thanked.

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NON-AERATED GAS BURNERS

(*Concluded from p. 401*)

diffusion. It would therefore be expected that with a burner with a larger orifice the supply of air to the central portion of the gas stream might be delayed, compared with a smaller orifice. In the case of the larger orifice, therefore, a proportion of the gas stream may have an air gas mixture inside the explosive limits for a longer period and the extinction point would be raised.

It would be interesting to know to what extent the results obtained by the Authors may have been influenced by frictional effects at the walls of the steatite orifices of the industrial burner jets. Such effects would be of smaller magnitude in drilled tube burners. If frictional effects do occur, then they would exert a greater influence at lower orifice sizes, and one would expect that the pressure could be raised to a higher value before the gas velocity reached the blowing-off value.

Professor **D. T. A. Townend** (Livesey Professor): It is a pleasure to record our appreciation at Leeds of the extensive and valuable work carried out by Mr. Fuidge and his collaborators in the South Metropolitan Laboratories. The scope of this investigation has now been extended to cover an amply wide range of burners in everyday use, so that any criticism as to the limitation of applicability of previously published results has now been met. It should now be possible, with any gas supply usually met in practice, to form a fair idea of the conditions necessary for stability in a particular appliance.

We are particularly interested in the Authors' description of the unstable flame state observed with industrial burner jets, as the supply pressure is increased until the feed velocity approaches the blow-off value. This observation falls into line with the flow states of unignited media observed by ourselves at suitable feed velocities; it also accords well with the observations of Brown.(1)

The only minor matter for comment is the Authors' use of the term "dead-space" in relation to the distance between the "ignition ring" of a non-aerated flame and the burner wall. We prefer to limit the use of "dead-space" to the distance between an *aerated* inner-cone flame and the burner head; this distance we regard as attributable to a thermal gradient. Smith and Pickering's(2) expression "overhang" would be more appropriate to the dimension discussed by the Authors.

(1) G. B. Brown.—*Phil. Mag.*, 1932, **18**, 175.
(2) F. A. Smith and S. F. Pickering.—*J. Res. Nat. Bur. Stand.*, 1936, **17**, 7.

Monmouthshire Industrial Exhibition

The Monmouthshire County Council, in association with the Newport Borough Council and local industrialists, is staging an exhibition at the Technical College, Newport, from Oct. 7 to 14. It is designed to show not only the wide range of the County's products, but also the resources and potentialities of Monmouthshire as a site for new post-war industries and for the expansion of existing undertakings.

All the larger firms in Newport and the County are to show examples of their products, and it is hoped that many industrialists in other parts of the country, who are interested in post-war development, will visit Newport during the week of the exhibition and see for themselves what Monmouthshire can offer.

The opening ceremony will be performed by the Minister of Reconstruction, Lord Woolton.

Enquiries should be addressed to The Hon. Organizer, Monmouthshire Industrial Exhibition, County Hall, Newport, Mon.

A Meeting of the Midland Junior Association will be held in the room of the Midland Counties Coke Association, King Edward House, New Street, Birmingham, at 4.15 p.m. on Oct. 4, when an Address will be given by F. J. Dent, D.Sc., Ph.D. (Joint Assistant Director, Gas Research Board), on the "Production of Gaseous Hydrocarbons by the Hydrogenation of Coal."

Recent Publications by Griffin & Tatlock, Ltd., Kemble Street, London, W.C. 2, include an informative leaflet on their apparatus for the determination of benzole, toluene, and phenols in the gas, coke oven, and plastics industries. Other leaflets deal with nitrogen-in-steel determination apparatus, ball mills, anti-vibration balance tables, a new super-hard glass-cutting knife, balance desiccators, and polishing alumina, a new product specially prepared and accurately graded for use in the rapid scratch-free polishing of specimens for metallographic examination.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in the "Journal" should not be taken as an indication that they are necessarily available for export.